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The Time-Course of Competition

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Introduction

- **Competition**: similar but not identical words are hard to say in sequence
- leads to higher error rates (Butterworth & Whittaker 1980) and longer planning and execution time (Meyer & Gordon 1985, Yaniv et al. 1990, Rogers & Storkel 1998)
- greater effects for sequences with mismatching codas (e.g. *top tock*) than mismatching onsets (e.g. *top cop*)

Aims of this study:

- **Connection between speech planning and speech errors**: do error prone word sequences also show longer **planning** and **execution times**?
- which parts of the whole sequence are affected by **competition**?
- Any difference between **CVC** and **CV** sequences?

➠ **Experiment**: observe effects of competition on planning time and on articulatory kinematics during a delayed naming reaction-time experiment using EMA

Background: Relevant approaches

1. **Editing** of motor plans
   - a new plan can reuse parts of a previous plan
   - ➔ fully or partly identical words are produced faster than dissimilar words (Rosenbaum et al. 1986, Sternberger et al. 1988)
2. **Sequential cuing model** (Sevald & Dell 1994)
   - higher *inhibition* for coda mismatch: because same onsets miscue the wrong coda, slowing down the production
   - *facilitation/no competition* for different onsets because after the coda nothing follows to be miscued
   - ➔ position matters: onsets cue onsets and codas, but codas cue codas only
3. **Frequency locking**: change from a 1:2 to a 1:1 ratio, e.g.
   - cop cop: dorsal gestures are in a 1:1 ratio with labial gestures
   - top cop: apical and dorsal are in a 1:2 ratio with labial gestures
   - ➔ coproduced intrusion errors with continuously varying amplitudes (Goldstein et al. 2007, Pouplier & Goldstein 2005)
   - ➔ slowing down of production for less stable ratios (only for CVC)

Materials and Methods

EMA Experiment

- **delayed naming task** for measuring planning and execution time
  - 7 native AE speakers (2 males, 5 females)
  - visual presentation of target word
  - subjects produced initial schwa, then target word following stimulus AFAP
  - auditory (beep) stimulus occurred with random delay ranging from 1-2 sec
  - sensors on tongue, lower incisors, lower lip, upper lip and references

Materials

- sequences of two words
- 8 repetitions of each pair
- conditions: same (*top top*), onset different (*top cop*), coda different (*top tock*)

Table: conditions with examples and number of different word sequences

	CVC pairs		CV pairs	
	Example	sets	Example	
same	*top top*	10	*pay pay*	6
onset different (OD)	*top cop*	10	*pay Kay*	6
coda different (CD)	*top tock*	9	---	

Measurements: Latencies and durations for the naming task

Statistics

- Linear Mixed Effects Models with participant and items as random factors
- fixed effect: same (*top top*), onset different (*top cop*), coda different (*top tock*)
- dependent variables: planning time, execution time, durations of gestures and target overlap

Results:

1. Planning time

CVC
- measured at peak velocity of the initial gesture
- planning time is longer for sequences of different items than of same items
- no significant difference between mismatching onset (OD) and mismatching coda (CD)

⇨ **same < OD = CD**

CV
- no difference for CV

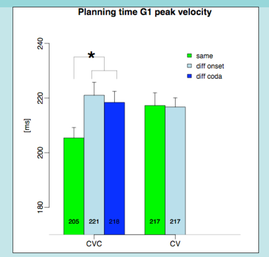


Fig. 1. Means and standard errors for planning time from 6 participants

2. Execution time

CVC
- The average execution time was 33 ms longer for items with different codas (e.g. *cop cot*), and 23 ms longer for different onsets (*cop top*), than for same items (*cop cop*)
- a smaller but significant difference between sequences of same items and with mismatching onsets

⇨ **same < OD ≪ CD**

CV
- no significant difference for CV

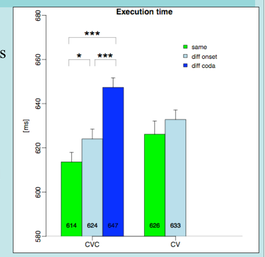
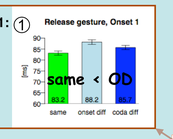


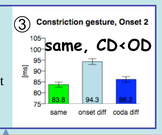
Fig. 2. Means and standard errors for execution time from 7 participants

3. Location of lengthening

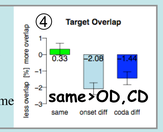
Release gesture, Onset 1:
- *same* < OD: 5 ms
- speaker-specific
- 5 out of 7 speakers



Constriction gesture Onset 2:
- *same*, CD < OD: 9 ms
- speaker-specific
- all speakers: OD longest



Relative Target Overlap:
- e.g. /p#t/ in *cop top*
- *same* more overlap than OD, CD: 2 %
- speaker-specific
- all speakers: most overlap same



Release gesture, Coda 1:
(not shown in gestural score)
- *same*, OD < CD: 4 ms
- not speaker-specific
- 5 out of 7 speakers

Big box: Gestural score for the consonantal gestures during the CVC word pairs
Surrounding boxes: significantly different gestures or coordination measures

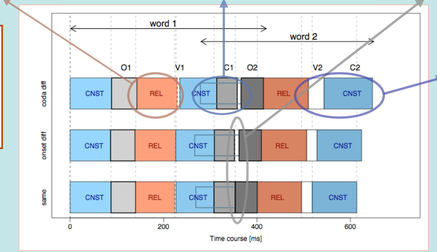
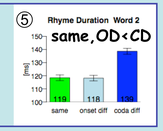


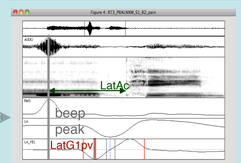
Fig. 3. Pseudo gestural score based on measurements of consonantal movements from 7 speakers. Blue boxes: constriction gestures, grey boxes: target region, orange boxes: release gestures, white: lag between gestures. Open box: constriction gesture for onset of the second word.

"Rhyme" Word 2:
- *same*, OD < CD: 20 ms
- not speaker-specific
- all speakers: CD longest

➠ **most robust effect**



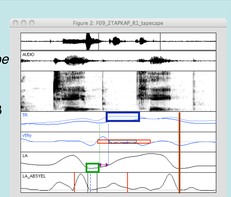
Labeling details



Articulatory latency
- **LatG1pv**: from beep peak to velocity peak of first gesture (for /p/ measured at lip aperture signal)

Target overlap between medial consonants
e.g. tape cape
- **Target2:** from gesture for bilabial stop in *tape*
- **Target3:** from gesture for the velar stop in *cape*
- **TargetOverlap**: CodaTarget2-OnsetTarget3
- Positive: overlap, negative: no overlap
- normalized by execution time

Execution time
- CVC: from the onset of the initial gesture to the closure of the final segment (ItemEnd)
- CV: from the onset of the initial gesture to the acoustic offset of the final vowel



Summary

1. Effect of similarity:
Identical CVC words have
- shorter RT
- shorter execution time
- shorter lag between words

} repeating units is beneficial

BUT: no beneficial repetition effect for CV word pairs

2. Locality
- no locality effect in planning time, only in execution time (cp. Figs 1 & 2)

2.1. Mismatch in coda (e.g. *cop cot*)
- longer execution time for coda mismatch than for onset mismatch
- main locus of lengthening: final rime
- in agreement with **Sequential Cuing Model:** reactivation of the first word causes inhibition of the final coda

BUT: release gesture of first coda also lengthens

2.2. Mismatch in onset (e.g. *cop top*)
- some lengthening for onset mismatch compared to word repetition
- in agreement with Sevald & Dell (1994) since for sequences of identical words more segments can be reused

BUT: not only newly activated **second** onset lengthens but also the **first** onset

3. Location of lengthening
- lengthening does **not** spread **uniformly** across the 2 words
- editing tends to affect the syllable position that is edited, i.e.
  - both codas are lengthened for coda mismatch
  - both onsets are lengthened for onset mismatch

Discussion

1. Role of the coda
- onset mismatch increases RT for CVC words but **NOT** for CV words
- ☒ cannot be explained by Sequential Cuing Model/Editing View
- ➔ **frequency locking**:
  - dynamically more stable 1:1 mode competes with 1:2 mode, causing slowdown
  - no 1:2 frequency locking without a coda

2. Temporal planning of utterances
- temporal planning is not completed when executing the first gestures
- e.g. longer lag between different words: delay due to continued planning and suppression of the transition from 1:2 to 1:1 mode?

Possible alternative approach: cascading activation from phonological plan to articulatory execution (Goldrick & Blumstein 2006)

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Acknowledgments

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